US007037091B2

(12) **United States Patent**
Chumley et al.

(10) **Patent No.: US 7,037,091 B2**
(45) **Date of Patent: May 2, 2006**

(54) **CRANKCASE HEATER MOUNTING FOR A COMPRESSOR**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 358 days.

(21) Appl. No.: **10/440,755**

(22) Filed: **May 19, 2003**

(65) **Prior Publication Data**

US 2004/0234388 A1 Nov. 25, 2004

(51) **Int. Cl.**
F01M 5/00 (2006.01)

(52) **U.S. Cl.** **417/572**; 417/902; 184/6.22

(58) **Field of Classification Search** 417/423.14, 417/572, 902; 184/6.22

See application file for complete search history.

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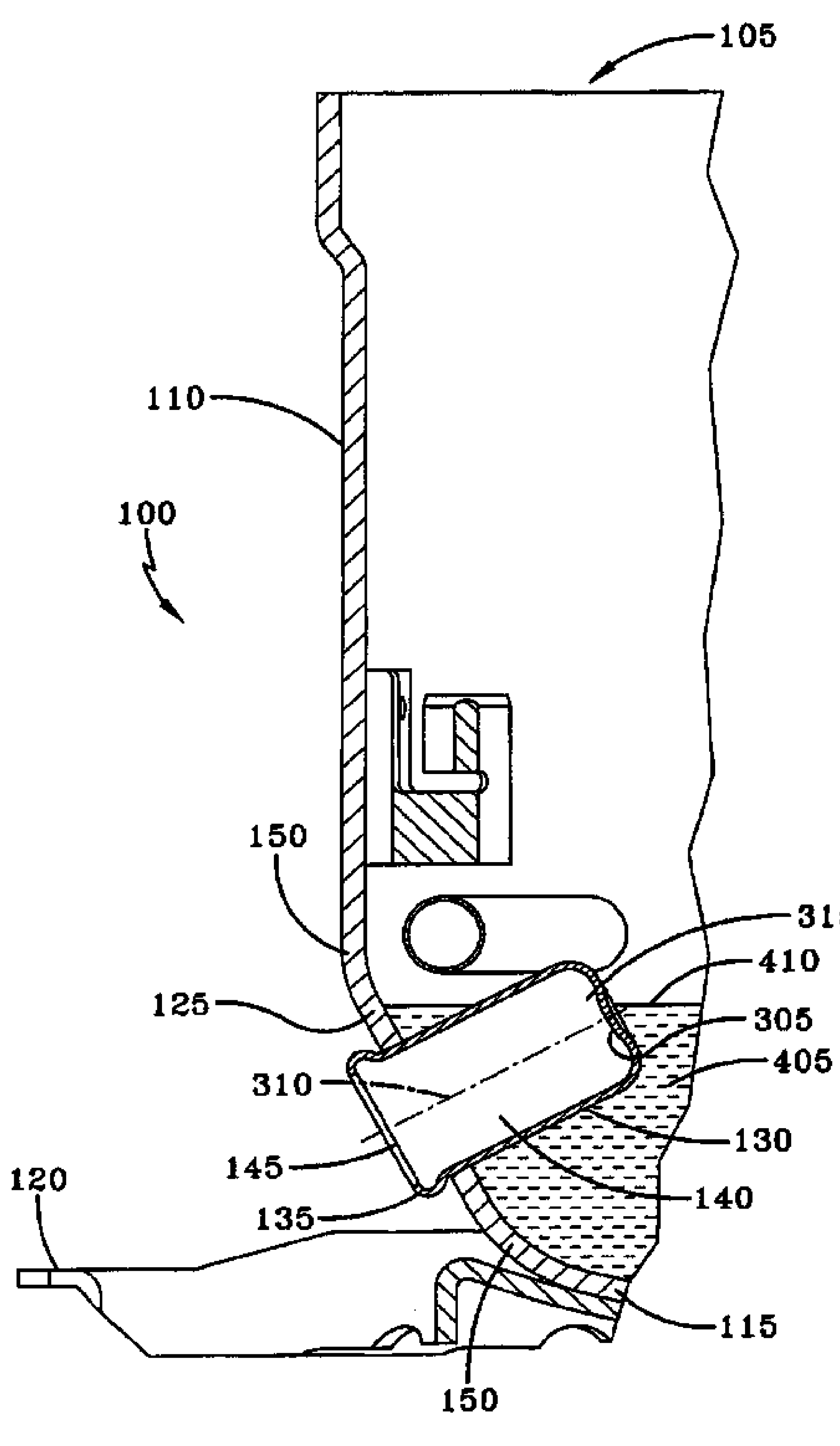
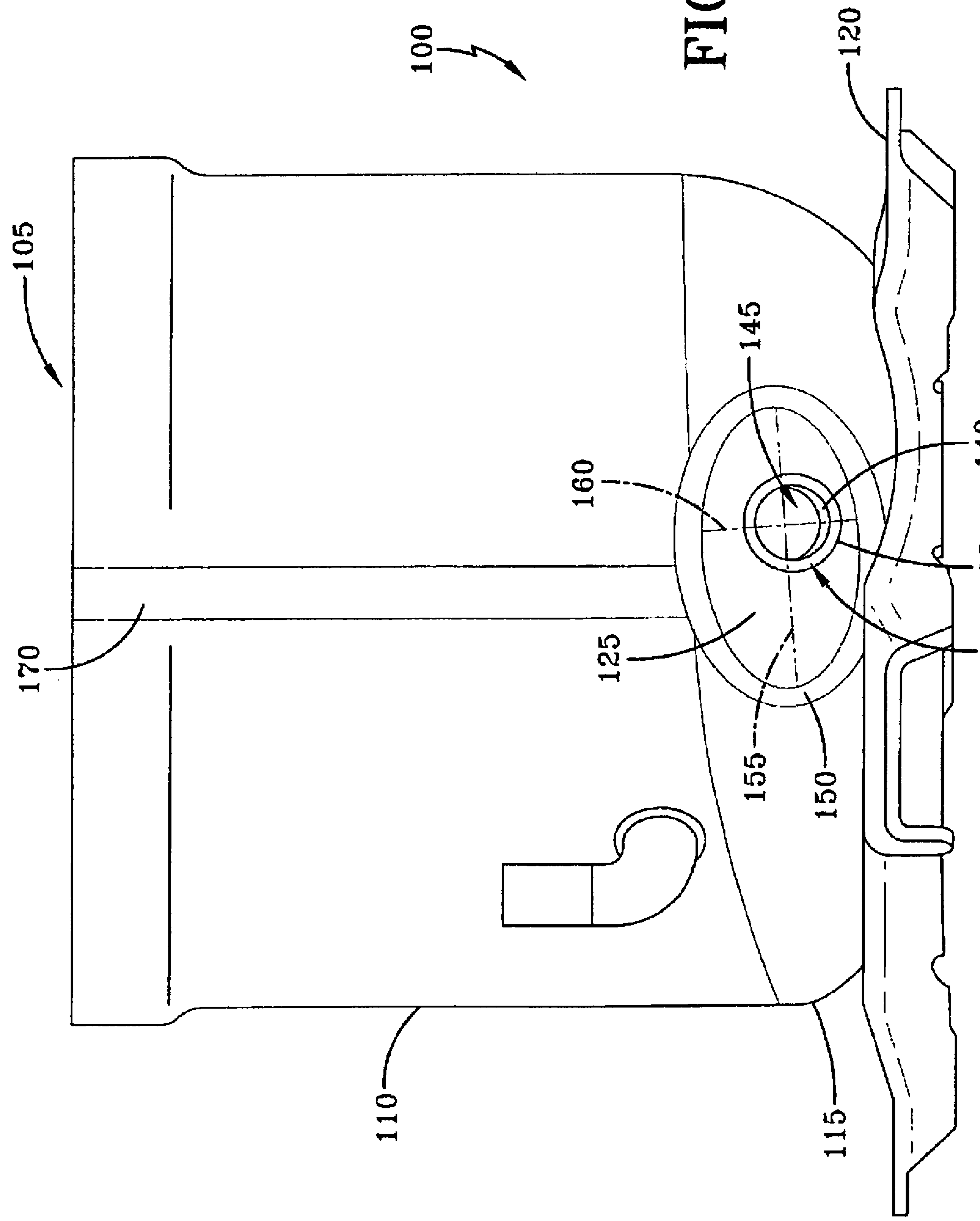
(57) **ABSTRACT**

A crankcase heater mounting and compressor system that efficiently heats the oil sump fluid in an oil sump of a crankcase. A heater well is disposed in a substantially planar section in the lower housing shell of the crankcase. The inner surface of the heater well is substantially submerged in the oil sump fluid even at low oil sump fluid levels.

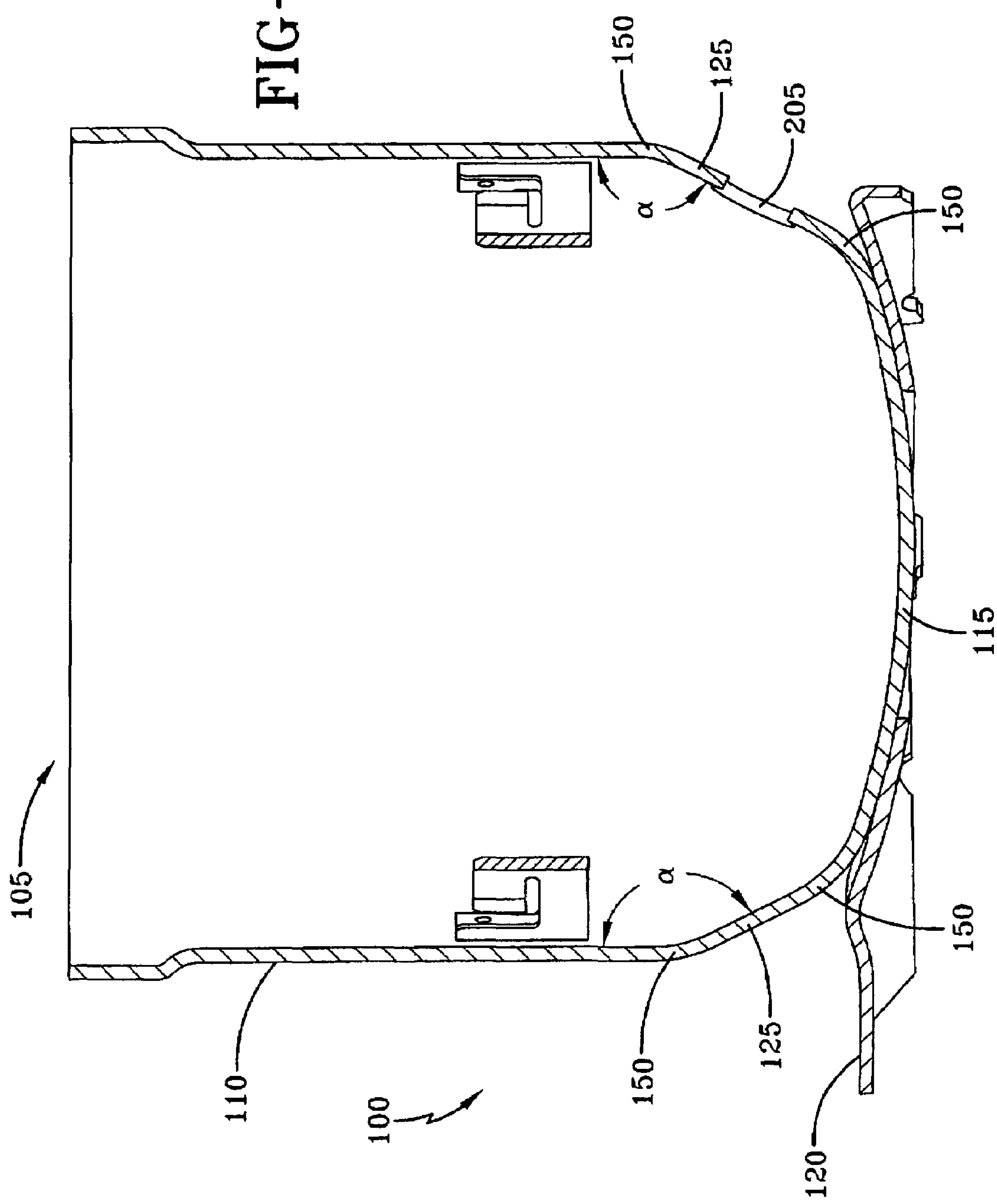
24 Claims, 5 Drawing Sheets

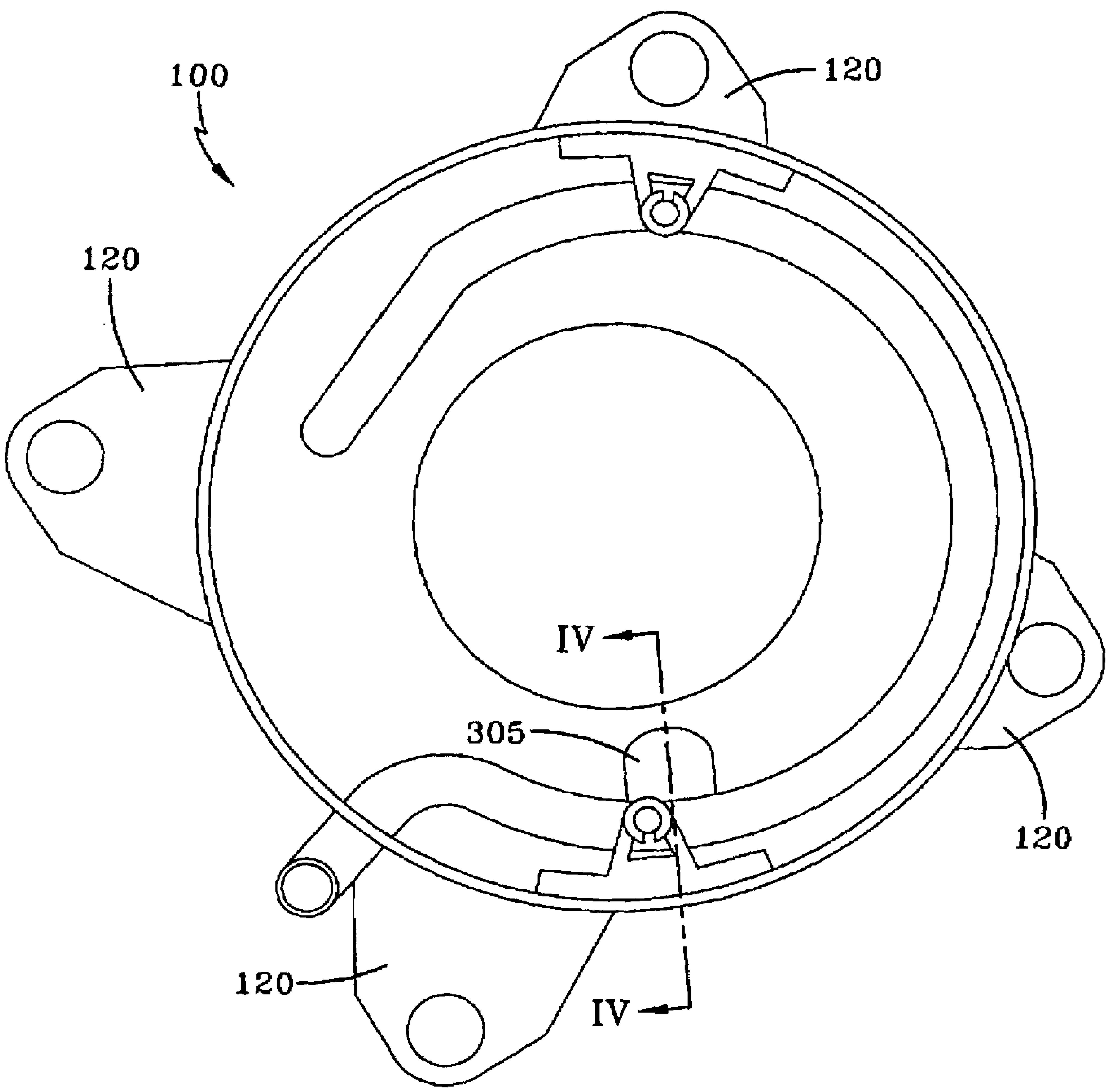




FIG—1

FIG-2





FIG–3

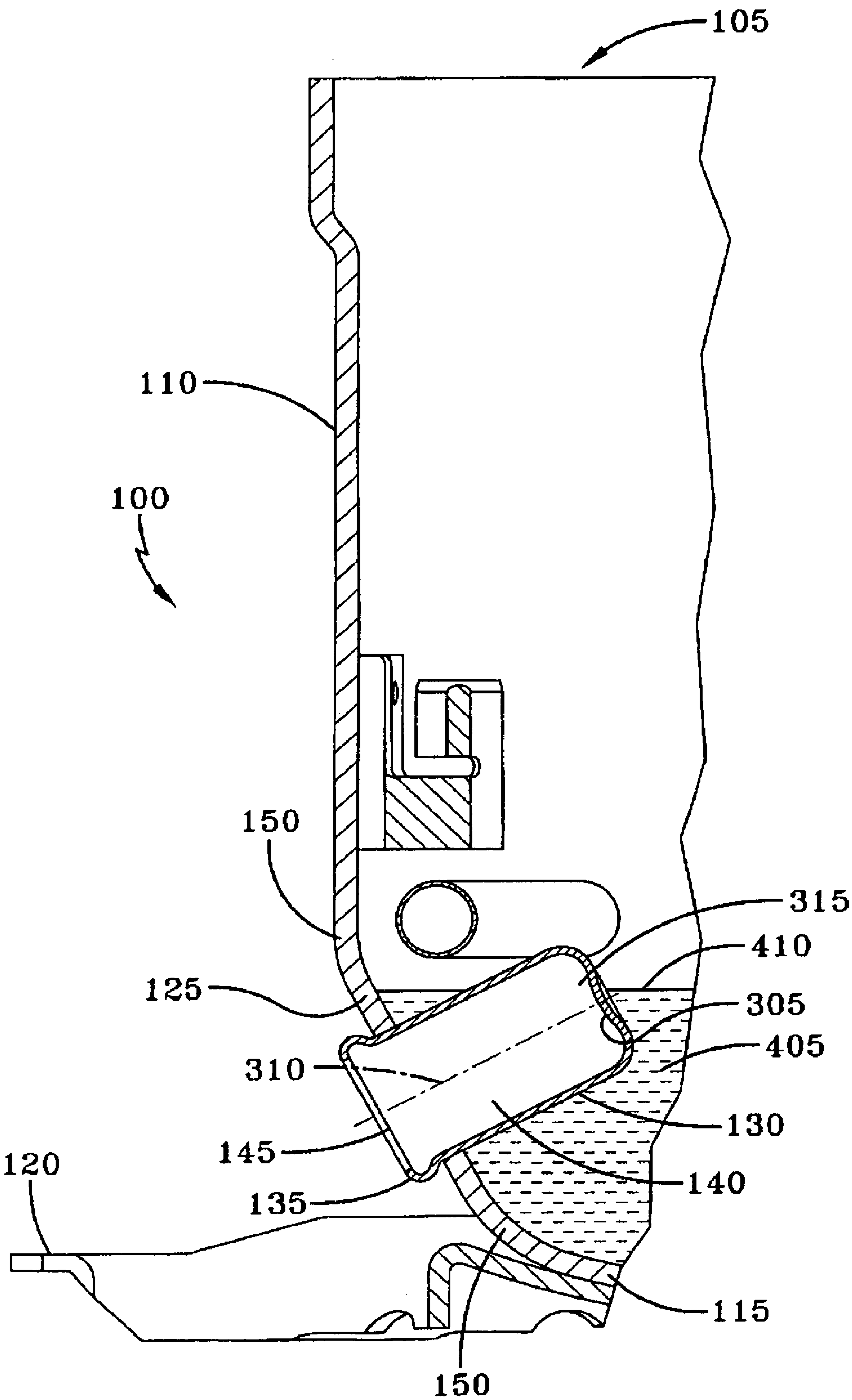

105
110
100
150
315
410
125
305
405
310
130
145
140
120
135
115
150

FIG-4

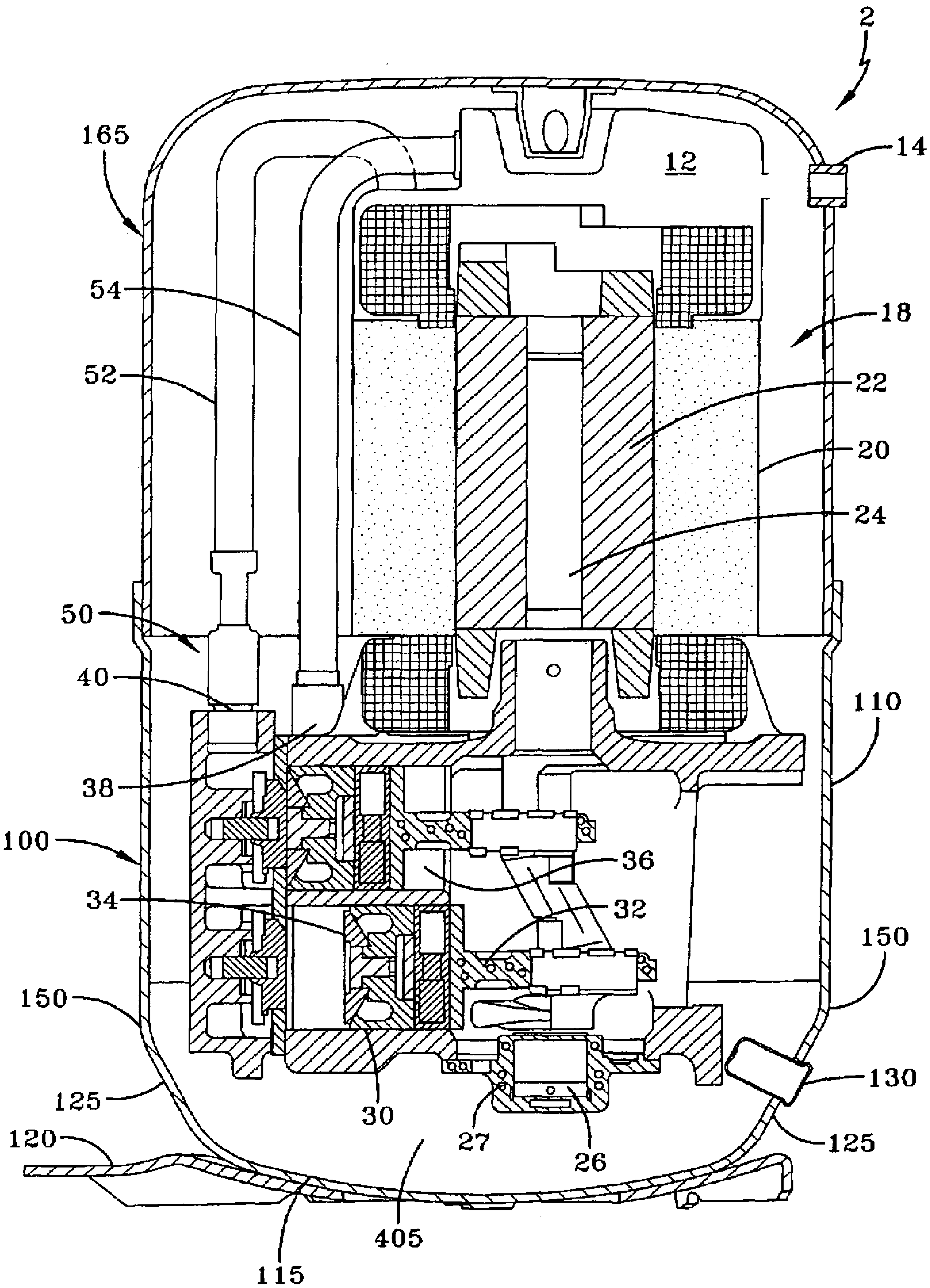

2
14
12
165
54
18
52
22
20
24
50
40
110
38
100
36
34
32
150
150
130
125
30
27
26
125
120
405
115

FIG-5

CRANKCASE HEATER MOUNTING FOR A COMPRESSOR

FIELD OF THE INVENTION

The present invention is directed to a mounting for a beater in the oil reservoir of a compressor crankcase in order to heat the liquid in the reservoir and evaporate any liquid refrigerant that may be present in the oil reservoir.

BACKGROUND OF THE INVENTION

The invention concerns refrigeration or heating, ventilation, and air conditioning ("HVAC") compressor units of the hermetically sealed type wherein the compressor housing or "shell" encloses the compressor, its drive motor and associated components. The compressor housing typically includes upper and lower cup shaped sections, which, after the compressor, motor, and associated components are mounted therein, are secured together, e.g., by welding along the peripheral mating joint formed by the mated contiguous open end portions of the shell sections.

It is customary in the design and manufacture of such compressors to dimension and configure the shell sections to adequately accommodate, spacewise, the compressor, its motor, and the various auxiliary components, such as, a motor mounting, a suction feed system, a discharge loop, a discharge muffler, and the like. Such design considerations are important, however, other design needs such as diminishing the inherent property of the shell to transmit objectionable noise at objectionable frequencies should be considered and are often compromised by paramount space considerations such as the dimensions and configuration of the refrigeration or air conditioning system housing or cabinet into which the compressor unit must precisely fit.

Objectionable noise is transmitted by the shell and originates or propagates therein either by the mechanical elements of the compressor such as the suction and discharge valves, or by the compression of the refrigerant therein, e.g., pulsations within the suction or discharge system. In this regard, it is recognized by those skilled in the art that the source of the noise, its mode of propagation within the shell, and its manner of transmission by the shell to the human ear are all extremely difficult to understand and predict, and of course, to control.

One of the key components for the operation of the compressor is the oil that is used for the lubrication of the mechanical components of the compressor. The oil to be used in the compressor collects in the oil sump at the base of the lower section of the compressor housing and is pumped or drawn into the moving compressor components from the sump.

Normal operation of the compressor also involves pumping refrigerant though the compressor. Such refrigerant is ideally maintained in gaseous form during its time within the compressor. However, some of the refrigerant may condense and drain into the oil sump. Such condensation can cause dilution of the oil in the oil sump, which hinders the ability of the oil to lubricate the mechanical components of the compressor. It is desirable to have no refrigerant in the oil within the oil sump.

Typically, the oil sump is heated with a heater assembly in order to evaporate any refrigerant condensate that accumulates in the oil sump. The heater assembly is normally positioned in a heater well that is located in the compressor housing near the oil sump. However, because of compressor design considerations the heater well is positioned perpendicularly to, and within, the generally cylindrical side of the compressor. Such a configuration means that the heater well is not always substantially submerged within the oil. At best, the well is only partially submerged into the oil of the oil sump, with the heater well mounted directly on the side of the substantially cylindrical compressor housing. In addition to failing to efficiently transfer heat from the heater to the oil, such a heater well configuration causes a significant amount of sound and other vibrations created by the operation of the compressor to be projected out into the environment.

In addition, the patent literature shows many variations of compressor unit shell heating assembly configurations, including U.S. Pat. Nos. 5,194,717; 5,252,036; and 4,755,657, which attempt to address these existing problems. These heating assemblies are directed toward heating elements that are mounted on the exterior wall of the crankcase and are not designed to function within a heater well element.

What is required is a crankcase heater assembly that causes less noise and vibration from the operation from the compressor to be projected out into the environment to reduce the volume of the sound and intensity of the vibration caused by normal compressor operation and to more efficiently transfer heat from the heating element to the oil in order to more quickly vaporize coolant.

SUMMARY OF THE INVENTION

The present invention is directed to a hermetic compressor crankcase housing and a hermetic compressor system.

The present invention hermetic compressor housing unit includes a shell having an upper and lower section. Both the upper and lower sections have substantially cylindrical portions or sidewalls with an open end, which, when mated, form a generally cylindrical shell. The lower section has a base portion that is positioned opposite the open end of its substantially cylindrical portion. The base portion is bowl shaped and has one or more substantially planar portions disposed adjacent to and below the substantially cylindrical portion. The substantially planar portion is disposed at an obtuse angle to a plane tangent to the substantially cylindrical sidewall of the lower section.

A heater well, with an outer surface and an inner surface, is disposed or positioned on a substantially planar portion in the lower section of the housing and extends into the interior of the lower section of the housing. The inner surface of the heater well faces the interior of the housing, while a portion of the outer surface of the heater well forms a chamber having an opening. The chamber is designed to receive a heater assembly. Such heater assemblies are well known in the art. The geometry of the housing, particularly location and geometry of the substantially planar surface in the lower section of the housing and the location of the heater well serves to diminish the inherent property of the shell to transmit objectionable noise and vibration at objectionable frequencies when compared to prior art shells. The smaller the surface area of the substantially planar section, and the more vertical the substantially planar section, the less sound and vibration is generated by the shell. However, if the heater wall were mounted on the vertical sidewall of the housing, the amount of sound and vibration generated during operation of the compressor would be increased.

The compressor system provided by the present invention is designed to function with many types of presently manufactured internal components, including systems that utilize single or multiple cylinders, motors and auxiliary components. The hermetic compressor housing unit has a shell having an upper and lower section which both have substantially cylindrical portions and which, when mated, form a generally cylindrical shell. The lower section has a base portion that is positioned adjacent to and below its substantially cylindrical portion. The base portion also has one or more substantially planar portions disposed adjacent to and below the substantially cylindrical portion. The substantially planar portion is disposed at an obtuse angle to a plane tangent to the substantially cylindrical portion of the lower section.

An oil sump is also located in the interior of the lower section of the housing. The oil sump generally includes oil, but may include oil mixed with condensed refrigerant. The fluid within the oil sump, whether oil, refrigerant, other lubricant, or other fluid is referred to herein as oil sump fluid. During normal operation, refrigerant is pumped through the compressor. Ideally, the refrigerant remains in a vapor state as it is cycled through the compressor. However, condensed refrigerant in the compressor shell may drain into the oil sump at the base of the compressor.

Oil sump fluid occupies at least a preselected minimum volume within the oil sump, such minimum volume being occupied when the oil sump fluid does-not contain any refrigerant during normal operation of the compressor. When the oil occupies the preselected minimum volume within the oil sump, the oil sump fluid rises to a preselected minimum height in the oil sump. The drainage of condensed refrigerant into the oil sump increases the volume of the oil sump fluid above its minimum volume. The presence of any liquid refrigerant within the sump increases the level of the oil sump fluid above its minimum height during normal operation of the compressor.

A heater well, with an outer surface and an inner surface, is located within a substantially planar portion in the lower section of the housing. The inner surface of the heater well faces the interior of the housing, while a portion the outer surface of the heater well forms a chamber having an opening. A substantial-portion of the inner surface of the heater well is in contact with the oil sump fluid at the preselected minimum oil sump fluid level. At higher levels of oil sump fluid, the entire inner surface of the heater well is in contact with the oil sump fluid. The chamber is designed to receive a heater assembly, such heater assemblies being well known in the art. The geometry of the housing, particularly the location and geometry of the substantially planar portion in the lower section of the housing and the location of the heater well serves to diminish the inherent property of the shell to transmit objectionable noise and vibrations at objectionable frequencies.

It is important, during both start-up and normal operation of the compressor to keep any refrigerant within the compressor housing in a vapor state and out of the oil sump. Since the refrigerant vaporizes at a lower temperature than the oil, heating the oil sump fluid above the evaporation temperature of the refrigerant serves to vaporize the refrigerant without vaporizing the oil. As the refrigerant is vaporized, it increases the partial pressure of the refrigerant within the compressor. The higher refrigerant vapor pressure within the compressor serves to prevent further condensation of the refrigerant vapor in the compressor housing. Since the interior of the heater well is substantially immersed in the oil sump fluid, even at low oil sump fluid levels, the heat generated from the heater unit located in the heater well is efficiently transferred from the heater assembly into the oil sump fluid. This transmission of heat directly from the heater unit into the oil sump fluid within the oil sump efficiently heats the oil sump fluid, driving any refrigerant located in the oil sump out of the oil sump fluid.

An advantage of this invention is a reduction in the amount of noise and vibration generated by a hermetic compressor during normal operation resulting from the position of the heater well within a substantially planar section of the housing.

Another advantage of this invention is efficient heating of the oil sump fluid in the lower section of a hermetic compressor by having the inner surface of a heater well substantially submerged in the oil sump fluid even at minimum oil sump fluid levels.

Another advantage of this invention is to provide efficient heating of the oil sump fluid in the lower section of a hermetic compressor by having the inner surface of a heater well completely submerged in the oil sump fluid at high oil sump fluid levels.

Other features and advantages of the present invention will be apparent from the following more detailed description of the preferred embodiment, taken in conjunction with the accompanying drawings which illustrate, by way of example, the principles of the invention.

Another advantage of this invention is the ability to use a smaller heater well as the heater well is at an angle rather than positioned horizontally.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an side view of a lower compressor shell section of an embodiment of the present invention.

FIG. **2** is a side cross-sectional view of a lower compressor shell section of the present invention.

FIG. **3** is a partial top view of the lower compressor shell section of the present invention.

FIG. **4** is partial cross-sectional view of the lower compressor shell section of FIG. **3** take along line IV—IV.

FIG. **5** is a side cross-sectional view of a compressor system from one embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The compressor crankcase shell or housing of the present invention preferably has a generally cylindrical shape, and is dimensioned to enclose a compressing device, electric motor, and any corresponding auxiliary components such as a discharge muffler, suction line, motor cap or suction plenum, and the like. A typical compressor having utility for the present invention is shown in U.S. Pat. No. 4,995,791, the disclosure of which is incorporated herein by reference.

Referring now to FIG. **1**, the hermetic compressor of the present invention includes two sections, an upper section **165** (shown in FIG. **5**) and a lower section **100**, which are connected or secured together to form the compressor shell. The upper section **165** and lower section **100** are preferably formed by a metal drawing operation from low carbon sheet steel of a substantially uniform thickness. It is understood that the upper section **165** and lower section **100** can be formed by any suitable process and can have any suitable thickness. The lower section **100** has a substantially cup or bowl shape. The lower section **100** has an opening **105**, a substantially cylindrical sidewall **110** extending from the opening **105**, and a closed end portion or base section **115** disposed opposite the opening **105**. A mounting foot **120** supports the base section **115**. In a preferred embodiment of the invention, the opening of the upper shell section **165** is designed to nest or fit within the opening **105** of the lower shell section **100**. The upper section **165** and lower section **100** are preferably connected by welding to form the housing, although other suitable techniques can be used. The opening **105** of the lower section **100** has a generally circular or more preferably oval cross-sectional geometry.

The base section **115** has one or more substantially planar sections **125** that are disposed adjacent to and below the substantially cylindrical section **110**. In a preferred embodiment of the present invention, the base section **115** has a pair of substantially planar sections **125** disposed on opposite sides of the lower section **100**. The one or more substantially planar sections **125** are preferably elongated closed geometric shapes with a major axis **155** having a length in the range of about 2 inches to about 4 inches, and a minor axis **160** having a length in the range of about 1 inch to about 3 inches. The, major axis **155** extends in an elongated length of the closed geometric shape and the minor axis **160** extends in a non-elongated length of the closed geometric shape. The major axis **155** and the minor axis **160** are preferably substantially perpendicular to one another. As defined herein, "substantially perpendicular" means at an angle in the range of about perpendicular to about 20 degrees away from perpendicular.

The heater well **130** of the present invention is shown extending into the lower section **100**. Only the outer surface **135** of the heater well **130** is seen from this perspective. The outer surface **135** forms a chamber **140** with an opening **145**.

In a preferred embodiment, an outwardly curved transitional section **150** surrounds the substantially planar section **125**. The transitional sections **150** serve to transition the geometry of the substantially planar sections **125** into the geometry of the base section **115** and the substantially cylindrical section **110**, if necessary.

In one embodiment, a substantially linear segment **170** originates at the opening **105** of the lower section **100** and extends in the sidewall **110** of the lower section **100** toward the base section **115**. In the embodiment shown in FIG. **1**, the substantially linear segment **170** extends almost the entire length of the lower section **100** and the entire length of the substantially cylindrical sidewall **110** before being blended into the transitional section **150**.

Referring now to FIG. **2**, a side cross-sectional view of the lower section **100** again shows the elements of the present invention, including the opening **105** in the lower section **100**, the substantially cylindrical sidewall **110**, the base section **115**, a pair of substantially planar sections **125**, the transitional sections **150** and the mounting foot **120**. An opening **205** is clearly visible in one of the substantially planar sections **125**. The opening **205** is designed to receive the heater well **130** of the present invention. The substantially planar sections **125** are disposed at an obtuse angle α (as shown in FIG. **2**) in the range of about 145° to about 160° to a plane tangent to the substantially cylindrical sidewall **110** of the lower section **100**. In a preferred embodiment, the substantially planar sections **125** are disposed at an obtuse angle a of about 153°.

Referring now to FIG. **3**, the partial top view of the lower section **100** illustrates the preferred positioning and substantially cylindrical-shape of the heater well **130** of the present invention. As this is a top view of the compressor housing, only the inner surface **305** of the heater well **130** is visible in addition to some other components. A portion of the mounting foot **120** is also visible from this perspective.

Referring now to FIG. **4**, which clearly shows the features of the preferred embodiment of the present invention. The opening **105** of the lower section **100**, the substantially cylindrical sidewall **110**, the base section **115**, the substantially planar section **125**, the transitional section **150** and the mounting foot **120** are visible. The heater well **130** is clearly disposed in the substantially planar section **125** and extends into the lower section **100** where the oil sump **405** is located. The oil sump **405** contains oil sump fluid, which includes oil or an oil and refrigerant mixture. In a preferred embodiment, the center axis **310** of the heater well **130** is positioned substantially perpendicularly to the substantially planar section **125**, the opening **145** in the chamber is substantially circular, and length of the heater well **130** along the center axis **310** is greater than the diameter of the opening **145**. In another embodiment, the diameter of the opening **145** and the length of the heater well **130** may be varied to any suitable sizes. In a preferred embodiment, the substantially circular opening **145** has a diameter in the range of about 0.5 inch to about 1.5 inches. The geometry of the opening **145** is not limited to substantially circular and may be of any geometric shape sufficient to receive a heater, such as a D-shape or other geometric shape.

The inner surface **305** of the heater well **130** faces the interior of the lower section **100**, while a portion the outer surface **135** of the heater well **130** forms a chamber **140** having an opening **145**. A portion of the outer surface **135** of the heater well **130** preferably may form a collar to assist in the welding of the heater well to the lower section **100**. The collar also prevents the heater well **130** from falling into the compressor by pushing through the opening **205**. The chamber **140** is designed to receive a heater assembly. Such heater assemblies are well known in the art.

In a preferred embodiment, the heater well **130** has a thickness less than the lower section **100** in order to more rapidly transmit heat through the heater well **130** into the oil sump **405**. Additionally, while it is preferable to hermetically weld the heater well **130** to the lower section **100**, the heater well **130** may be manufactured as a unitary component with the lower section **100**, provided that the connection between the heater well **130** and the lower section **100** is watertight. The heater well **130** attached to the lower section **100** is referred to herein as the heater mounting.

The level **410** of oil sump fluid in the oil sump **405** illustrates the minimum level **410** of oil sump fluid in the oil sump **405** required to maintain proper operation of the compressor. The oil occupies at least a preselected minimum volume within the oil sump **405**, such minimum volume being occupied when the oil sump **405** does not contain any refrigerant as is shown by oil sump fluid level **410** in FIG. **4**. During normal operation of the compressor, refrigerant is cycled through the compressor. Ideally, the refrigerant remains in a vapor state before it is cycled through the compressor. However, condensed refrigerant may form in the compressor shell and drain into the oil sump **405** at the base of the compressor. Such drainage of refrigerant into the oil sump **405** increases the volume of the oil sump fluid above its minimum volume. The presence of any refrigerant within the oil sump **405** increases the level of the oil sump fluid level **410** above its minimum normal operating height. During operation of the compressor, the level of the oil sump fluid could rise above the minimum normal operating level due to the drainage of condensed refrigerant (not shown) into the oil sump **405**, which increases the minimum level **410** of oil sump fluid in the oil sump **405**. In one embodiment of the present invention, the inner surface **305** of the heater well **130** preferably remains submerged in the oil sump fluid at all times.

It is important, during both start-up and normal operation of the compressor to keep any refrigerant within the compressor housing in a vapor state and out of the oil sump **405**.

Since the refrigerant vaporizes at a lower temperature than the oil **410**, heating the oil **410** above the evaporation temperature of the refrigerant serves to vaporize the refrigerant without vaporizing the oil **410**. As the refrigerant is vaporized, it increases the partial pressure of the refrigerant within the compressor. In the present invention, the heater well **130** is designed to receive a heating element (not shown). Such heating elements are well known in the art. When the heating element is turned on, heat is created by the heating element and is transferred from the heater element through the heater well **130** into the oil sump fluid in the oil sump **405**. Since the inner surface **305** of the heater well **130** is substantially immersed in the oil sump fluid, even at low oil sump fluid levels where the oil sump fluid is almost completely oil, the heat generated from the heater unit located in the heater well is efficiently transferred from the heater assembly into the oil sump fluid. In a preferred embodiment, about two-thirds of the inner surface **305** of heater well **130** is immersed in the oil sump fluid. In a preferred embodiment, during start-up condition where a substantial amount of refrigerant is present in the oil sump, the inner surface of the heater well **130** is completely immersed in the oil sump fluid. This transmission of heat directly from the heater unit to the oil sump fluid efficiently heats the oil sump fluid, driving any refrigerant located in the oil sump fluid out of the oil sump fluid. While the heater well **130** is preferably cylindrical in shape with a closed end **315**, it may be of any suitable geometric shape, as long as the inner surface **305** is completely submerged in the oil sump fluid of the oil sump **405**. In a preferred embodiment, the level **410** of the oil sump fluid is about 1.5 inches to about 2 inches. In an optional embodiment, fins are attached the heater well **130**, which increases the rate of transfer of heat from the heater to the oil sump fluid.

The geometry of the lower housing **100** and the position of the substantially planar section **125** and the heater well **130** in the lower shell serves to reduce the noise and other vibrations generated by the operation of the compressor. The location and geometry of the heater well **130** also serves to reduce the internal volume of the compressor that is occupied by the heater well. In a preferred embodiment, the presence of the transitional section **150** between the substantially planar section **125** and the substantially cylindrical section **110** and the base section **115** further serves to reduce the noise and other vibrations generated by the operation of the compressor. The noise and other vibrations produced by the heater well **130** and heater assembly during normal operation are reduced by placing the heater well **130** in an area of high mechanical impedance, which is an area that is inherently low in vibrational energy during normal compressor operation. The base portion **115** of the lower section **100** is an area of relatively high mechanical impedance and low sound radiation efficiency as compared to the substantially cylindrical sidewall **110**. By placing the heater well **130** in an relatively small substantially planar portion **125** of the base portion **115**, the sound radiation and fatigue failures of the heater well **130** are reduced when compared to a heater well that is placed in the cylindrical sidewall. The low sound radiation efficiency of the base portion **115** ensures low sound radiation from the heater well **130** and heater assembly, when the low vibration energy present at the heater well **130** location is taken into account.

Referring now to FIG. **5**, one embodiment of a compressor system that incorporates the heater mounting of the present invention is depicted in FIG. **5**. The compressor **2** is connected to a conventional refrigeration or HVAC system (not shown) having a condenser, expansion device and evaporator in fluid communication with the compressor **2**. Compressor **2** is preferably a reciprocating compressor connected to an evaporator (not shown) by a suction line that enters the suction port **14** of compressor **2**. Suction port **14** is in fluid communication with suction plenum **12**. Refrigerant gas from the evaporator enters the low pressure side of compressor **2** through suction port **14** and then flows to the suction plenum **12** before being compressed.

Compressor **2** includes an electrical motor **18**. A standard induction motor having a stator **20** and a rotor **22** is shown. However any other electrical motor may be used. A shaft assembly **24** extends through rotor **22**. The bottom end **26** of shaft assembly **24** in this compressor **2** extends into an oil sump **405** and includes a series of apertures **27**. Connected to shaft assembly **24** below the motor is at least one piston assembly **30**. Compressor **2** of FIG. **5** depicts two piston assemblies. A connecting rod **32** is connected to a piston head **34**, which moves back and forth within cylinder **36**. Cylinder includes a gas inlet port **38** and a gas discharge port **40**. Associated with these ports **38**, **40** are associated respectively suction valves and discharge valves (not shown) assembled in a manner well known in the art. Gas inlet port **38** is connected to an intake tube **54**, which is in fluid communication with suction plenum **12**.

Motor **18** is activated by a signal in response to a predetermined condition, for example, an electrical signal from a thermostat when a preset temperature is reached. Electricity is supplied to stator **20**, and the windings in the stator **20** causes rotor **22** to rotate. Rotation of rotor **22** causes the shaft assembly **24** to turn. In the compressor shown, oil sump fluid in the oil sump **405** and which has moved through apertures **27** in bottom end **26** of shaft is moved upward through and along shaft **24** to lubricate the moving parts of compressor **2**.

Rotation of rotor **22** also causes reciprocating motion of piston assembly **30**. As the assembly moves to an intake position, piston head **34** moves away from gas inlet port **38**, the suction valve opens and refrigerant fluid is introduced into an expanding cylinder **36** volume. This gas is pulled from suction plenum **12** within upper section **16**. This gas is sucked into intake tube **54** to gas inlet port **38** where it passes through suction valve and is introduced into cylinder **36**. When piston assembly **30** reaches a first end (or top) of its stroke, shown by movement of piston head **34** to the right side of cylinder **36** of FIG. **5**, suction valve closes. The piston head **34** then compresses the refrigerant gas by reducing the cylinder **36** volume. When piston assembly **30** moves to a second end (or bottom) of its stroke, shown by movement of piston head **34** to the left side of cylinder **36** of FIG. **5**, a discharge valve is opened and the highly compressed refrigerant gas is expelled through gas discharge port **40**. The highly compressed refrigerant gas flows from the gas discharge port **40** into a muffler **50** then through an exhaust or discharge tube **52**, exiting the compressor housing **16** into a conduit connected to a condenser. This comprises one cycle of the piston assembly **30**.

The heater well **130** of the present invention is clearly shown disposed in a substantially planar section **125** of the lower housing. The substantially cylindrical sidewall **110**, the base section **115**, transitional sections **150**, and the mounting foot **120** are also clearly visible.

While the invention has been described with reference to a preferred embodiment, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the appended claims.

We claim:

1. A shell section for a compressor, the shell section comprising:

a substantially cylindrical sidewall having an opening;

a base section connected to the substantially cylindrical sidewall and disposed opposite the opening, the base section having a substantially planar portion, wherein the substantially planar portion is disposed at an obtuse angle to a plane tangent to the substantially cylindrical sidewall; and

a heater extending from the substantially planar portion into the shell section, the heater well being disposed substantially perpendicular to the substantially planar portion.

2. The shell section of claim **1**, wherein the substantially planar section is disposed adjacent to the substantially cylindrical sidewall.

3. The shell section of claim **1**, wherein the heater well comprises an inner surface and an outer surface, a portion of the outer surface forming a chamber, said chamber having an opening.

4. The shell section of claim **3**, wherein the shell section further comprises an outwardly curved transitional portion, said transitional section being adjacent to the substantially cylindrical sidewall, the base section, and the substantially planar portion, said transitional portion surrounding the substantially planar portion, said transitional portion transitioning the geometry of the substantially planar portion into the geometry of the substantially cylindrical sidewall and the base section.

5. The shell section of claim **4**, wherein the heater well is substantially cylindrical with a closed end, wherein the heater well has a center axis, wherein the opening in the chamber is substantially circular, and wherein the center axis of the heater well is perpendicular to the substantially planar portion.

6. The shell section of claim **5**, wherein the length of the heater well along the center axis is greater than the diameter of the opening.

7. The shell section of claim **6**, wherein the obtuse angle is in the range of about 145 degrees to about 160 degrees.

8. The shell section of claim **7**, wherein the obtuse angle is about 153 degrees.

9. The shell section of claim **1**, wherein the obtuse angle is in the range of about 145 degrees to about 160 degrees.

10. The shell section of claim **9**, wherein the obtuse angle is about 153 degrees.

11. The shell section of claim **4**, wherein the obtuse angle is in the range of about 145 degrees to about 160 degrees.

12. The shell section of claim **11**, wherein the obtuse angle is about 153 degrees.

13. A compressor system comprising:

an upper section having a substantially cylindrical sidewall;

a lower section, having a substantially cylindrical sidewall, a base section connected to the substantially cylindrical sidewall and disposed opposite the upper section, the base section having a substantially planar portion, wherein the substantially planar portion is disposed at an obtuse angle to a plane tangent to the substantially cylindrical sidewall of the lower section;

an electric motor disposed in the housing;

a compression apparatus disposed in the housing, the compression apparatus being configured and disposed to be driven by the electric motor;

a fluid disposed in the lower section of the housing to form a sump, the fluid comprising oil to lubricate the compressor apparatus; and

a heater well extending from the lower section into the sum, the heater well being disposed to be substantially submerged in the fluid.

14. The compressor system of claim **13**, wherein the substantially planar portion is disposed adjacent to the substantially cylindrical sidewall.

15. The compressor system of claim **13**, wherein the heater mounting further comprises the heater well having an inner surface and an outer surface, a substantial portion of the inner surface of the heater well being submerged in the oil sump fluid, a portion of the outer surface forming a chamber, said chamber having an opening.

16. The compressor system of claim **15**, wherein the lower section further comprises an outwardly curved transitional portion, said transitional section being adjacent to the substantially cylindrical sidewall of the lower section, the base section, and the substantially planar portion, said transitional portion surrounding the substantially planar portion, said transitional portion transitioning the geometry of the substantially planar portion into the geometry of the substantially cylindrical sidewall of the lower section and the base section.

17. The compressor system of claim **16**, wherein the heater well is substantially cylindrical with a closed end, wherein the heater well has a center axis, wherein the opening in the chamber is substantially circular, wherein the center axis of the heater well is perpendicular to the substantially planar portion.

18. The compressor system of claim **17**, wherein the length of the heater well along the center axis is greater than the diameter of the opening.

19. The compressor system of claim **18**, wherein the obtuse angle is in the range of about 145 degrees to about 160 degrees.

20. The compressor system of claim **19**, wherein the obtuse angle is about 153 degrees.

21. The compressor system of claim **13**, wherein the obtuse angle is in the range of about 145 degrees to about 160 degrees.

22. The compressor system of claim **21**, wherein the obtuse angle is about 153 degrees.

23. The compressor system of claim **16**, wherein the obtuse angle is in the range of about 145 degrees to about 160 degrees.

24. The compressor system of claim **23**, wherein the obtuse angle is about 153 degrees.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 7,037,091 B2
APPLICATION NO. : 10/440755
DATED : May 2, 2006
INVENTOR(S) : Eugene Karl Chumley et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 5, Line 56, "angle a of" should be - - angle α of - - .

Column 10, Line 15 "sum" should be - - sump - -.

Signed and Sealed this

Twenty-second Day of August, 2006

Jon W. Dudas

JON W. DUDAS
Director of the United States Patent and Trademark Office